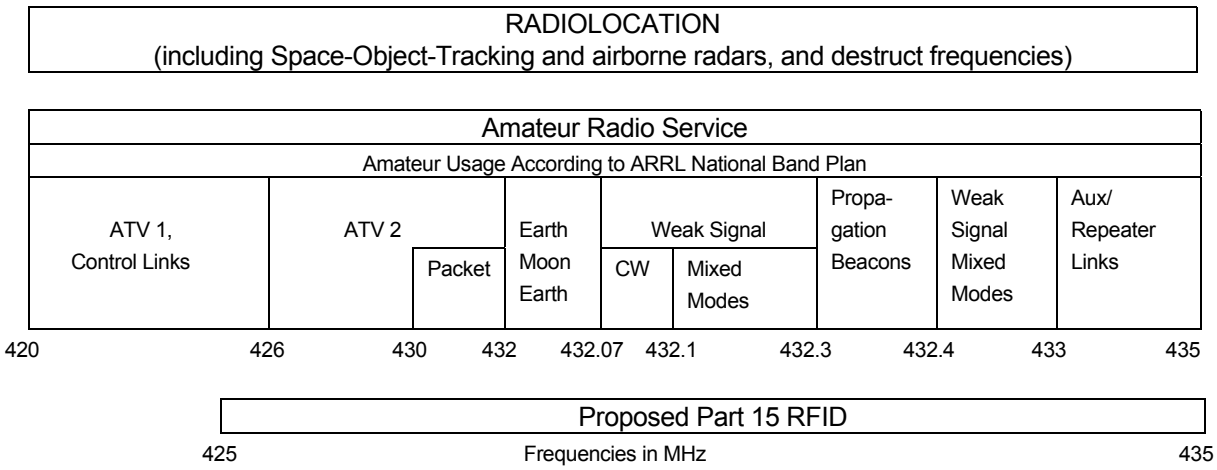
ARRL Ex Parte Presentation[1]
to the Office of Engineering and Technology
Federal Communications Commission
January 14, 2002

ARRL, the National Association for Amateur Radio, is seriously concerned that the Commission has proposed, in its *Notice of Proposed Rule Making and Order*, FCC 01-290, released October 15, 2001, to permit Radio Frequency Identification (RFID) systems to operate in the 425-435 MHz band. Therein, the Commission proposes to permit "periodic" radiators to operate in this band at peak field strengths of up to 110,000 □V/m measured at a distance of 3 meters, and continuous levels of up to 11,000 □V/m.

The 420-450 MHz band is allocated to Government radiolocation on a primary basis and to the Amateur Radio Service on a secondary basis, a sharing arrangement that has worked well. The following frequency chart illustrates current usage and the proposed RFID overlay:



This band is an extremely poor choice for these devices, due to the substantial interference potential to a large number of amateur stations operating in the band, especially at 432-433 MHz, for terrestrial weak-signal communications.

While ARRL has no objection to the operation of these devices at the proposed operating parameters in a different band, there is no reason whatsoever why the 425-435 MHz band should be considered for these high-duty-cycle devices, rather than another band already available for high powered Part 15 devices, where amateur weak-signal communications are not actively conducted.

The attached interference study, prepared by the ARRL Laboratory, establishes that the signal levels proposed for RFID systems at the duty cycles proposed to be permitted in this proceeding will cause substantial interference to amateur stations in excess of 1,000 meters from the RFID transmitter. The analysis of the interference potential to amateur stations was based on the typical RFID system described by Savi Technology in its ex parte presentation of April 12, 2001 (re: ET Docket 01-278).

[1] Presentation by ARRL General Counsel Christopher Imlay and Technical Relations Manager Paul Rinaldo. Laboratory study was prepared by Laboratory Supervisor Ed Hare and Senior Engineer Zack Lau.

Expected Signal Levels:

The following graphs show the expected signal levels at various distances from signal sources that have a field strength of 110,000 µV /m at 3 meters and 11,000 µV/m at 3 meters. These levels are shown for receive antennas of various gains. These antenna gains were chosen to be close to the antenna gain typically used in various amateur station configurations. These levels represent the peak and non-peak signal strength described in the NPRM.

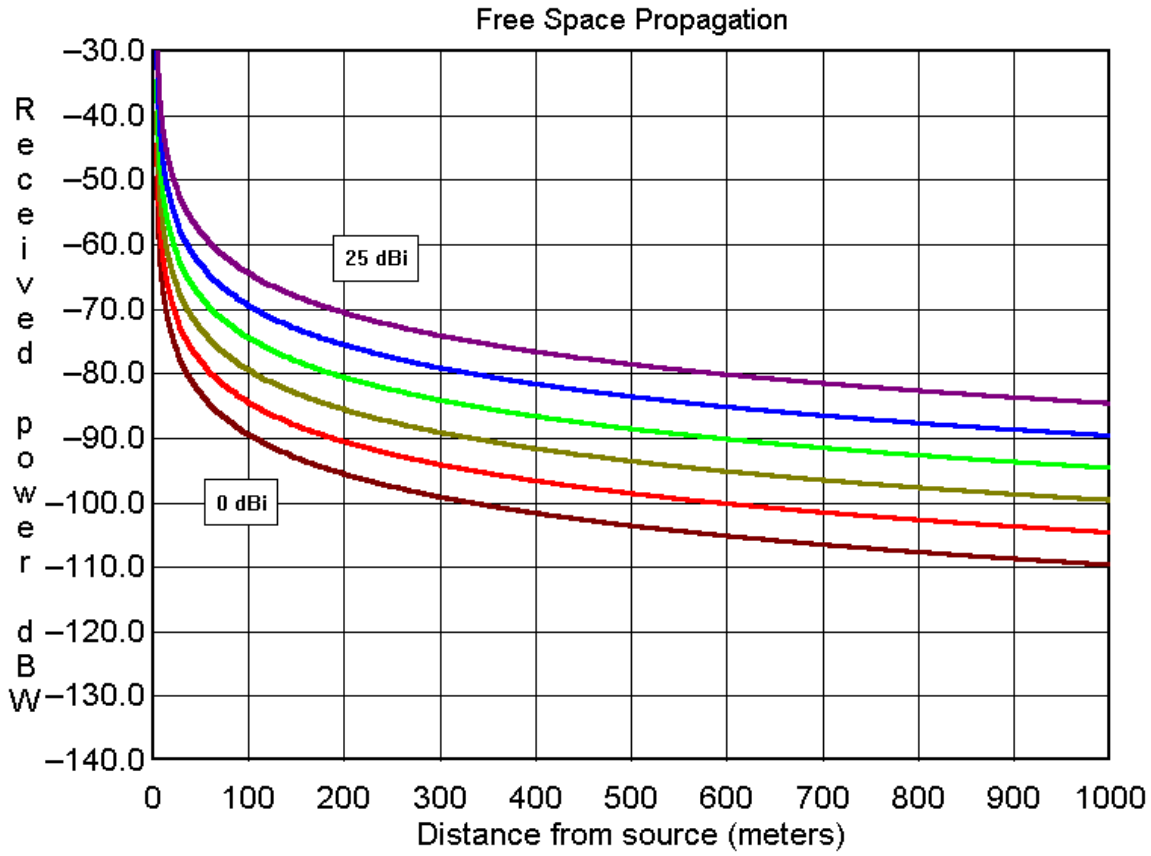


Figure 1: This graph shows the signal levels that will be delivered by a matched antenna with various gains on 433.92 MHz when it is placed at the specified distance from a field of 110,000 µV/m. This represents the maximum peak level proposed in ET 01-278. Free-space propagation is assumed.

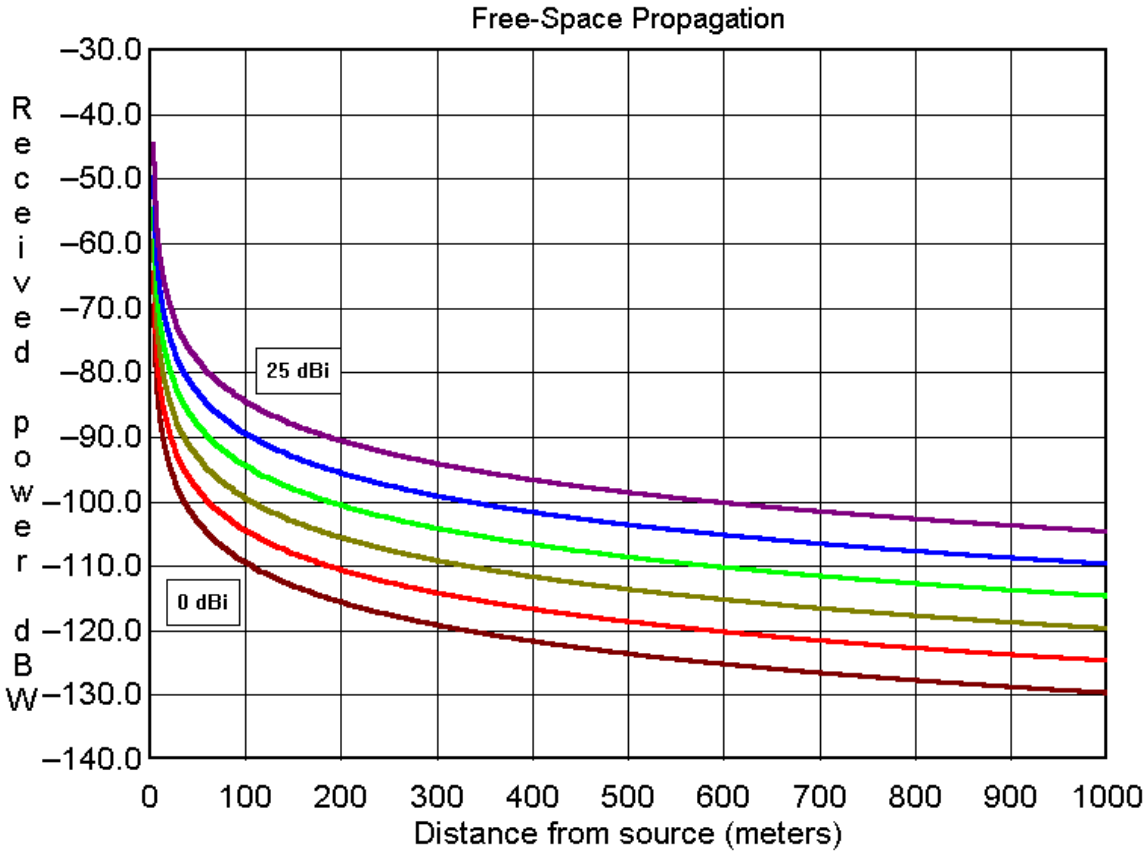


Figure 2: This graph shows the signal levels that will be delivered by a matched antenna with various gains on 433.92 MHz when it is placed at the specified distance from a field of 11,000 µV/m. This represents the non-peak, near-continuous level proposed in ET 01-278. Free-space propagation is assumed.

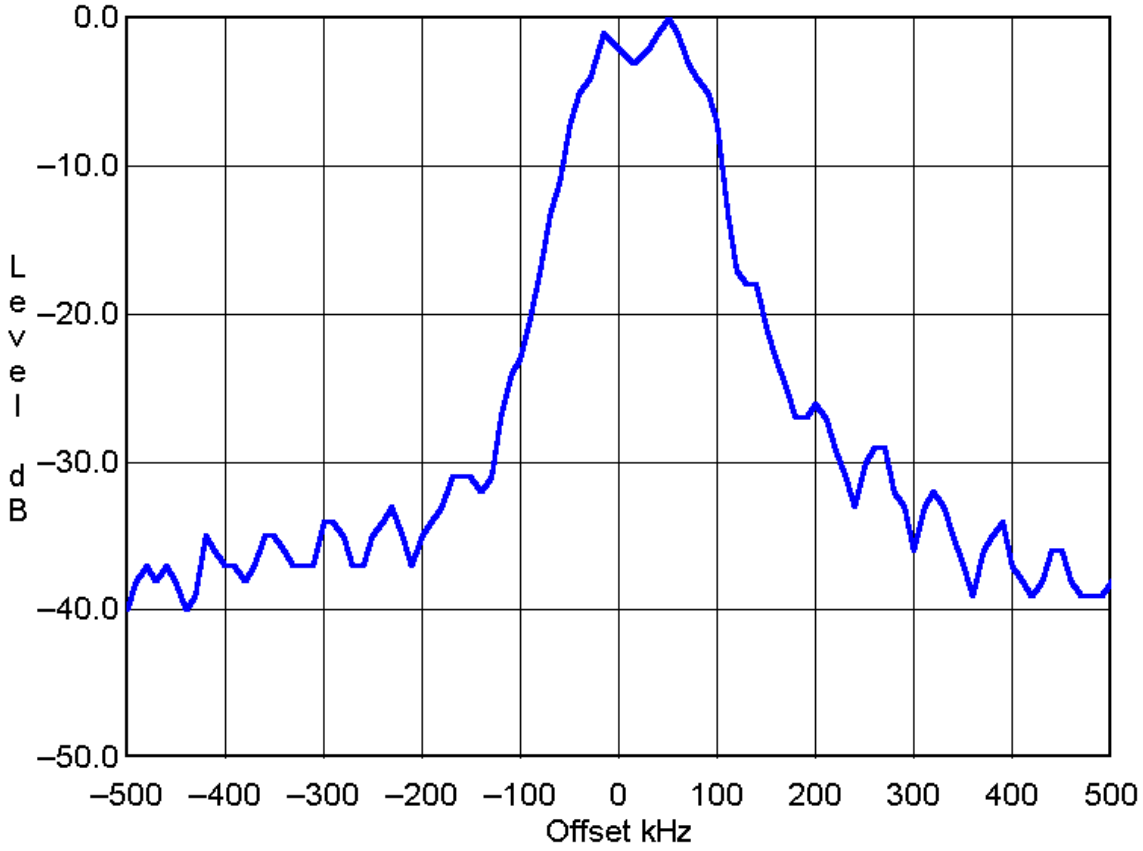


Figure 3: This is the typical occupied bandwidth of a SaviReader transmitter. (This is from Figure 1 from the ex parte presentation Savi made on April 12, 2001.) The –6 dB bandwidth is 140 kHz. The –26 dB bandwidth is 290 kHz.

Effect of RFID Signal on Specific Amateur Stations:

The following tables describe the operating parameters of amateur stations using different, typical operating modes. These modes and station configurations are by no means all inclusive. It should be noted that although most of the UHF RFID systems being proposed in conjunction with this rulemaking operate on 433.92 MHz, the rule-making procedure stipulates a frequency range of 425 to 435 MHz. The higher levels shown on these graphs represent the fundamental RFID signal, which, under the rules, could appear anywhere within that frequency range.

Typical FM Voice Amateur Station

The typical FM voice amateur station can communicate with other FM voice amateur stations using line-of sight and diffraction propagation modes.

Characteristics	Values
Frequency Band (MHz)	420-450MHz
Channel Spacing	Random, usually in 5-kHz steps
Information Rate	Speech
Emission Type(s)	15K0F3E or 15K0G3E
Transmitter Power (dBW)	14.0
Transmission Line Loss (dB)	3
Antenna Polarization	V
Antenna Maximum Gain (dBi)	5
Maximum e.i.r.p. (dBW)	16
Receiver IF Bandwidth	15 kHz
Receiver Noise Figure (dB)	2
Receiver Thermal Noise (dBW)	-157
Receiver Thermal Noise (dBm)	-127
Receiver Signal-to-Noise Ratio (dB)	+7 (for 12 dB SINAD)
Availability Target %	99
Maximum Path Length (km)	Depends on the propagation mode

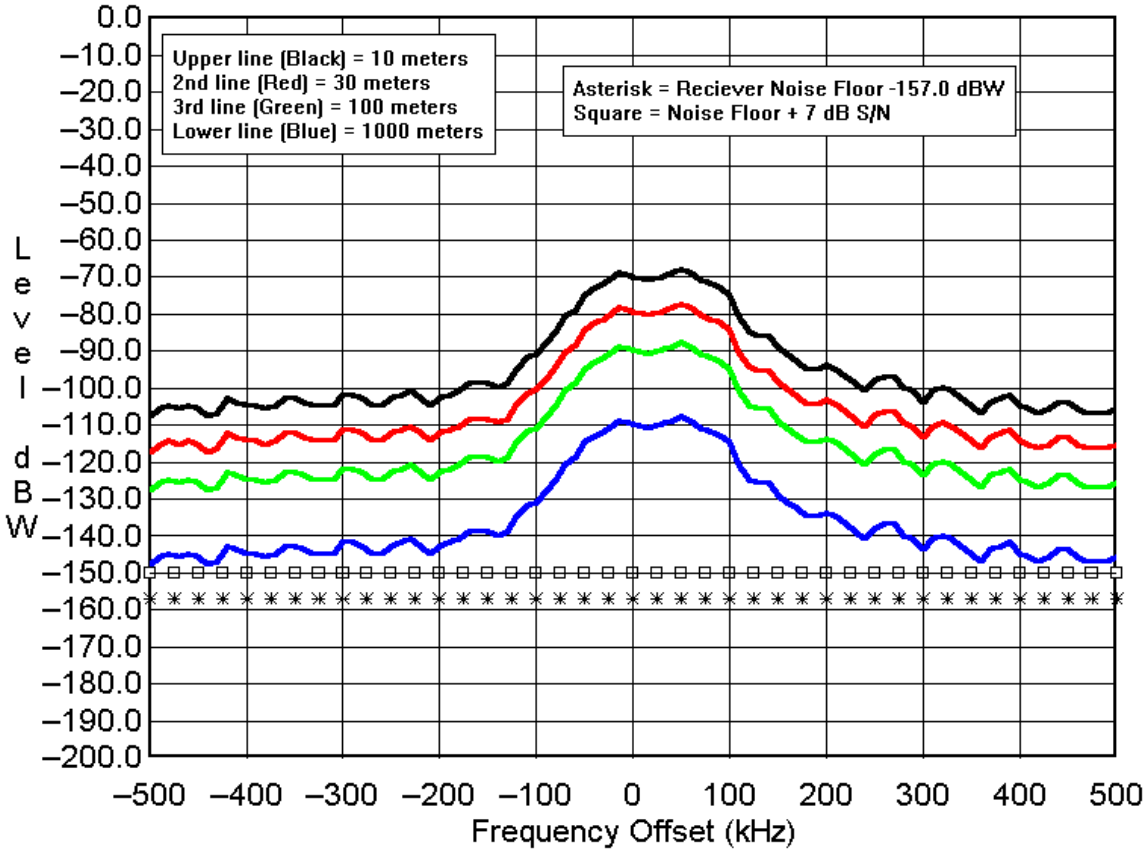


Figure 4. These data show the expected RFID system levels from the typical RFID transmitter generating 11,000 µV/m at 3 meters. The amateur station is an FM receiving station using a 5-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 11,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 3 dB to account for the receive system bandwidth of 15 kHz. This amateur station typically has about –157 dBW of receiver sensitivity and a signal margin of approximately 7 dB for minimal communication.

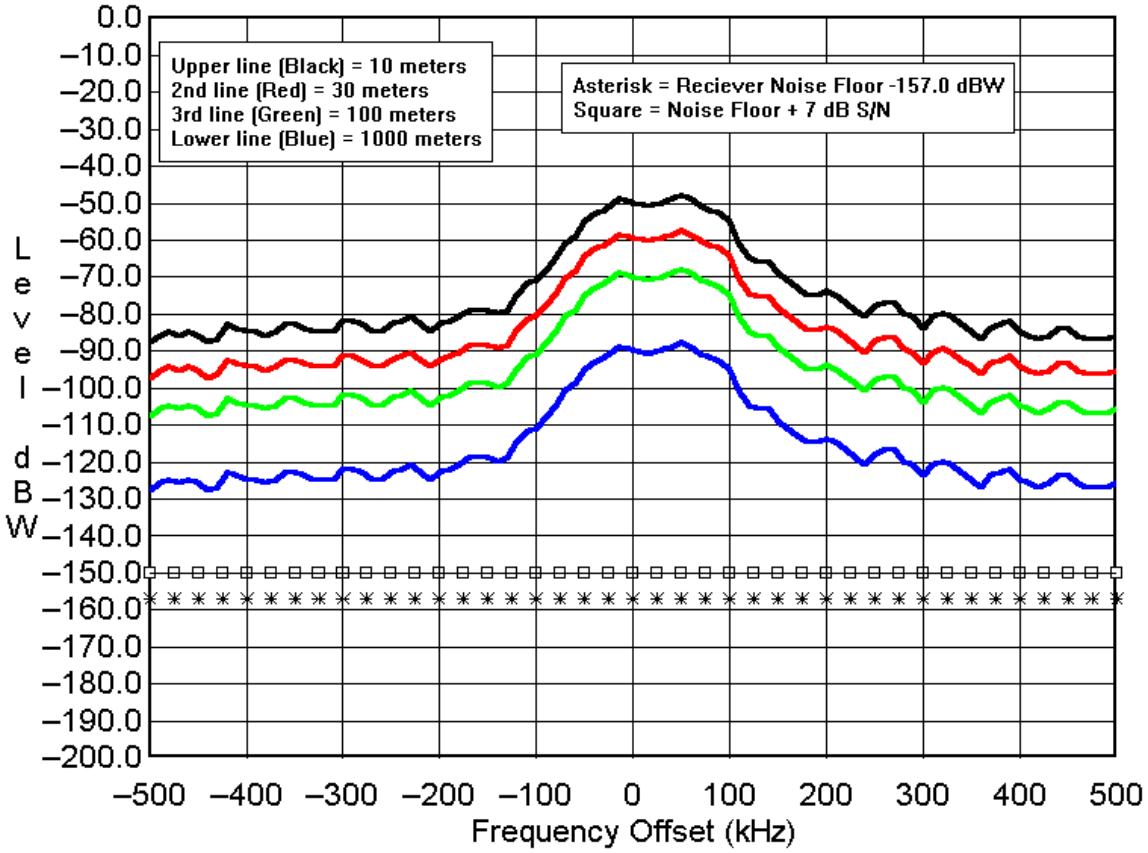


Figure 5. These data show the expected RFID system levels from the typical RFID transmitter generating 110,000 µV/m at 3 meters. The amateur station is an FM receiving station using a 5-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 110,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 3 dB to account for the receive system bandwidth of 15 kHz. This amateur station typically has –157 dBW of receiver sensitivity and a signal margin of approximately 7 dB for minimal communication.

Typical FM Voice Amateur Repeater Station

The typical FM voice amateur repeater station can communicate with other FM voice amateur stations using line-of-sight and diffraction propagation modes.

Characteristics	Values
Frequency Band (MHz)	420-431MHz, 433-435MHz, 438-450 MHz
Channel Spacing	25 kHz
Information Rate	Speech
Emission Type(s)	15K0F3E or 15K0G3E
Transmitter Power (dBW)	15
Transmission Line Loss (dB)	3
Antenna Polarization	V
Antenna Maximum Gain (dBi)	5 (300 m height above average terrain)
Maximum e.i.r.p. (dBW)	17
Receiver IF Bandwidth	15 kHz
Receiver Noise Figure (dB)	2
Receiver Thermal Noise (dBW)	-157.9
Receiver Thermal Noise (dBm)	-127.9
Receiver Signal-to-Noise Ratio (dB)	+7 (for 12 dB SINAD)
Availability Target %	99
Maximum Path Length (km)	Depends on the propagation mode

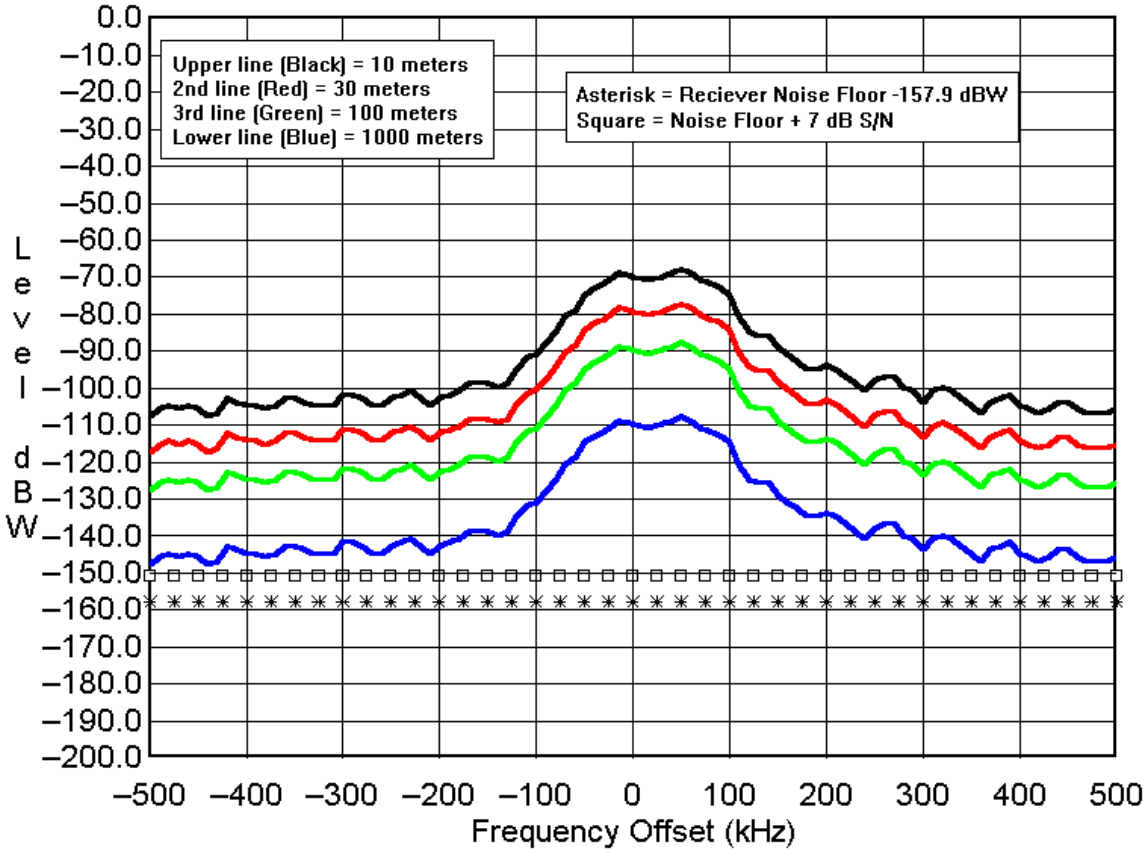


Figure 6. These data show the expected RFID system levels from the typical RFID transmitter generating 11,000 µV/m at 3 meters. The amateur station is an FM repeater receiving station using a 5-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 11,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 3 dB to account for the receive system bandwidth of 15 kHz. This amateur station typically has –157.9 dBW of receiver sensitivity and a signal margin of approximately 7 dB for minimal communication.

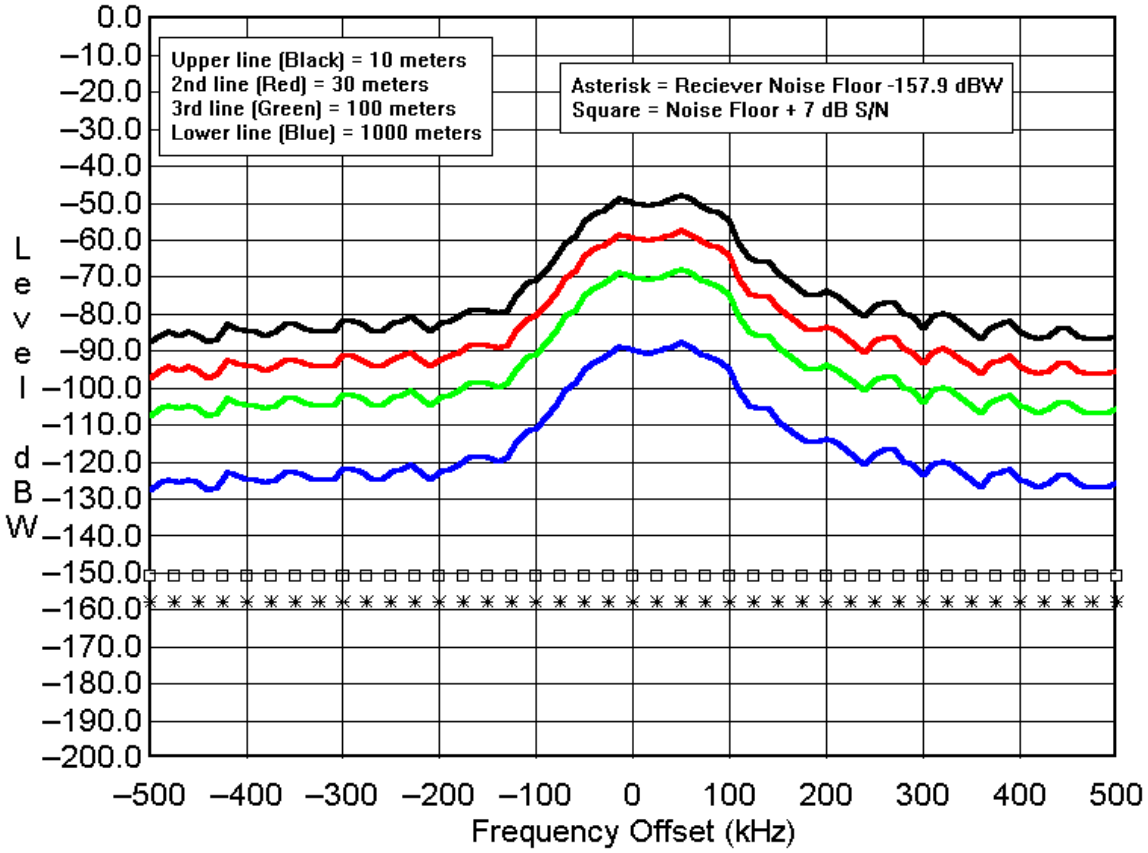


Figure 7. These data show the expected RFID system levels from the typical RFID transmitter generating 110,000 µV/m at 3 meters. The amateur station is an FM repeater receiving station using a 5-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 110,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 3 dB to account for the receive system bandwidth of 15 kHz. This amateur station typically has –157.9 dBW of receiver sensitivity and a signal margin of approximately 7 dB for minimal communication.

Typical SSB Amateur Station

The typical SSB amateur station can communicate with other SSB stations at maximum ranges using any propagation mode available at the time.

Characteristics	Values	
Frequency Band (MHz)	420-450	
Channel Spacing	Random	
Information Rate	Speech	
Emission Type(s)	2K50J3E	
Transmitter Power (dBW)	20.0	
Transmission Line Loss (dB)	Transmit: 2	Receive: 0
Antenna Polarization	H	
Antenna Maximum Gain (dBi)	17.9	
Maximum e.i.r.p. (dBW)	35.9	
Receiver IF Bandwidth	2.5 kHz	
Receiver Noise Figure (dB)	1	
Receiver Thermal Noise (dBW)	-171.0 (155 K background)	
Receiver Thermal Noise (dBm)	-141.0 (155 K background)	
Receiver Signal-to-Noise Ratio (dB)	+6	
Availability Target %	99	
Maximum Path Length (km)	Depends on the propagation mode	

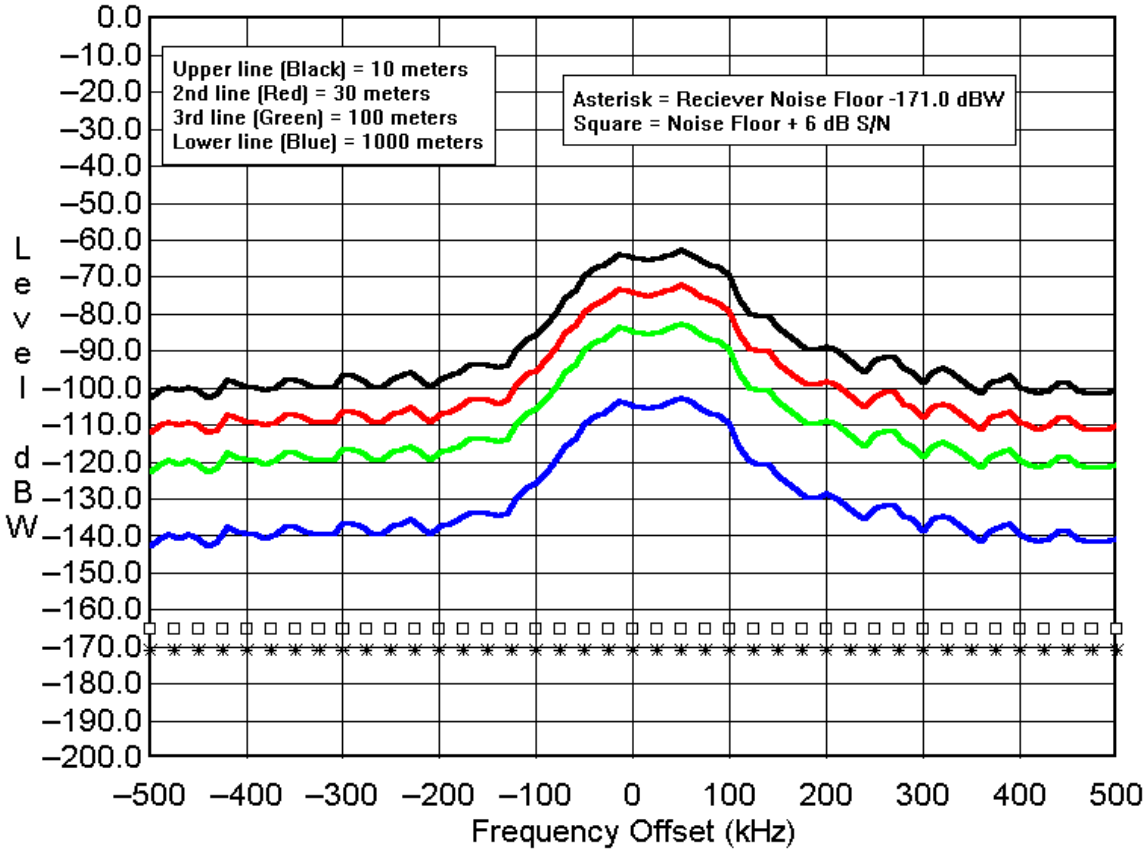


Figure 8. These data show the expected RFID system levels from the typical RFID transmitter generating 11,000 µV/m at 3 meters. The amateur station is an SSB terrestrial receiving station using a 17.9-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 11,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 10.8 dB to account for the receive system bandwidth of 2.5 kHz. This Amateur station typically has about –171.0 dBW of receiver sensitivity and a signal margin of approximately 6 dB for minimal communication.

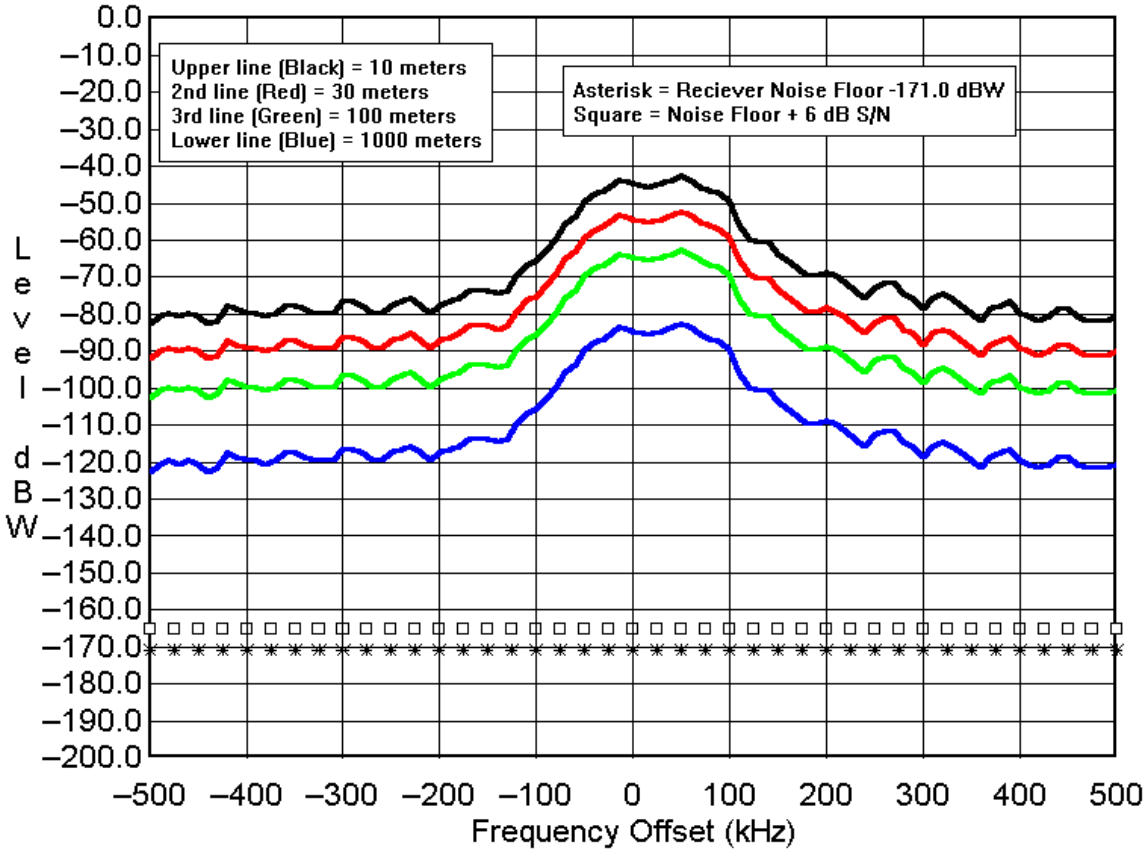


Figure 9. These data show the expected RFID system levels from the typical RFID transmitter generating 110,000 µV/m at 3 meters. The amateur station is an SSB terrestrial receiving station using a 17.9-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 110,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 10.8 dB to account for the receive system bandwidth of 2.5 kHz. This Amateur station typically has about –171.0 dBW of receiver sensitivity and a signal margin of approximately 6 dB for minimal communication.

Typical CW Amateur Station

The typical CW amateur station can communicate with other CW stations at maximum ranges using any propagation mode available at the time.

Characteristics	Values	
Frequency Band (MHz)	420-450	
Channel Spacing	Random	
Information Rate	CW: 10 bit/s	
Emission Type(s)	100HA1A	
Transmitter Power (dBW)	20.0	
Transmission Line Loss (dB)	Transmit: 2	Receive: 0
Antenna Polarization	Horizontal	
Antenna Maximum Gain (dBi)	17.9	
Maximum e.i.r.p. (dBW)	35.9	
Receiver IF Bandwidth	100 Hz	
Receiver Noise Figure (dB)	0.5	
Receiver Thermal Noise (dBW)	-185.8	
Receiver Thermal Noise (dBm)	-155.8	
Receiver Signal-to-Noise Ratio (dB)	+1	
Availability Target %	99	
Maximum Path Length (km)	Depends on the propagation mode	

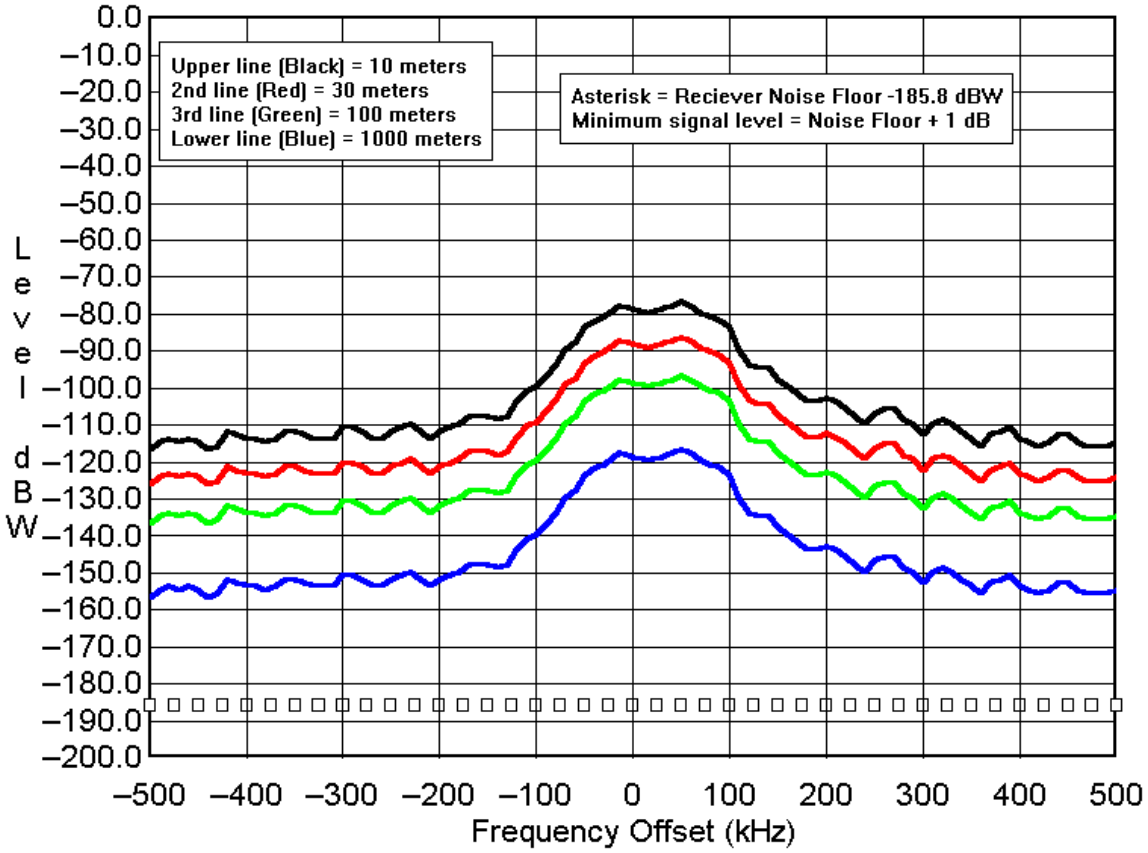


Figure 10. These data show the expected RFID system levels from the typical RFID transmitter generating 11,000 µV/m at 3 meters. The amateur station is a CW terrestrial receiving station using a 17.9-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 11,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 24.8 dB to account for the receive system bandwidth of 0.1 kHz. This amateur station typically has about –185.8 dBW of receiver sensitivity and a signal margin of approximately 1 dB for minimal communication.

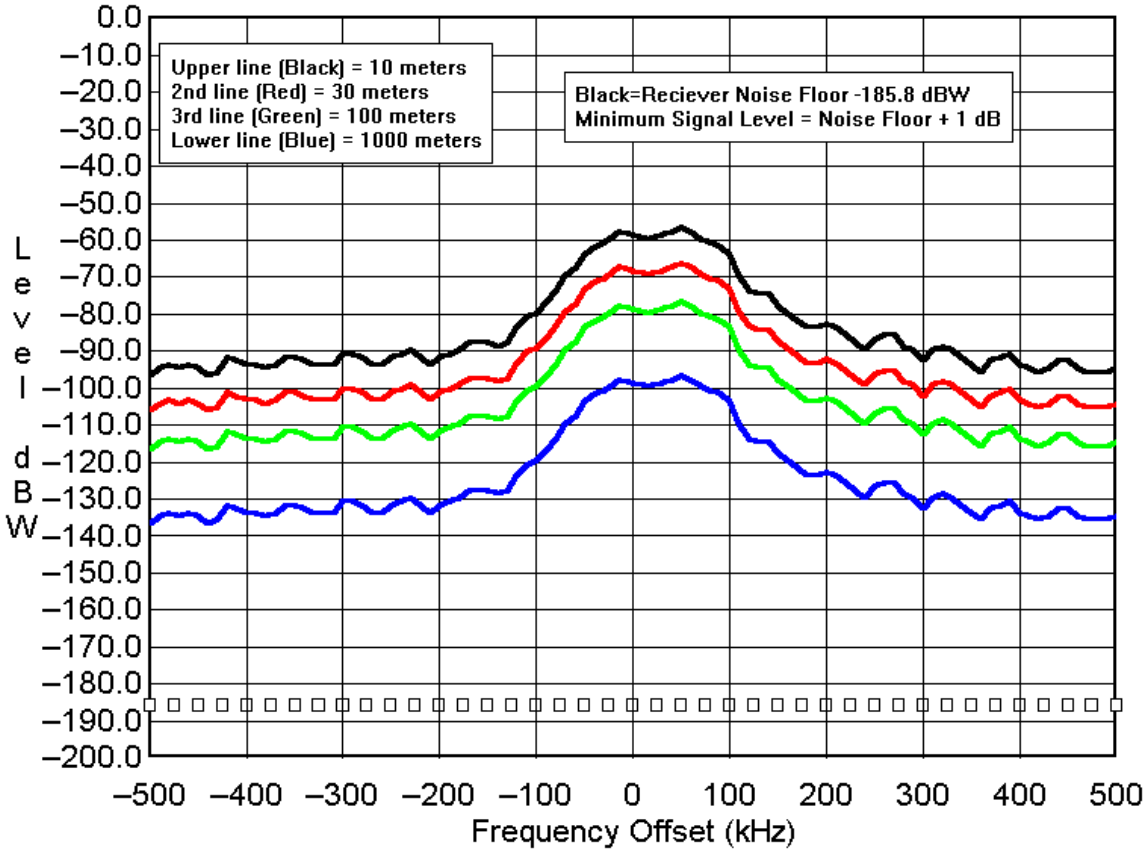


Figure 11. These data show the expected RFID system levels from the typical RFID transmitter generating 110,000 µV/m at 3 meters. The amateur station is a CW terrestrial receiving station using a 17.9-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 110,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 24.8 dB to account for the receive system bandwidth of 0.1 kHz. This amateur station typically has about –185.8 dBW of receiver sensitivity and a signal margin of approximately 1 dB for minimal communication.

Typical 70 cm EME Amateur Station

The typical EME model is capable of CW communication with any EME station.

Characteristics	Values	
Frequency Band (MHz)	420-450	
Channel Spacing	Random	
Information Rate	CW: 10 bit/s	
Emission Type(s)	50H0A1A	
Transmitter Power (dBW)	30	
Transmission Line Loss (dB)	Transmit: 1	Receive: 0
Antenna Polarization	H	
Antenna Maximum Gain (dBi)	26	
Maximum e.i.r.p. (dBW)	55	
Receiver IF Bandwidth	CW: 50 Hz	
Receiver Noise Figure (dB)	0.3	
Receiver Thermal Noise (dBW)	-195.5	
Receiver Thermal Noise (dBm)	-165.5	
Receiver Signal-to-Noise Ratio (dB)	+1	
Availability Target %	99 (when moon is in view)	
Maximum Path Length (km)	396,000 one way to moon at nominal apogee	

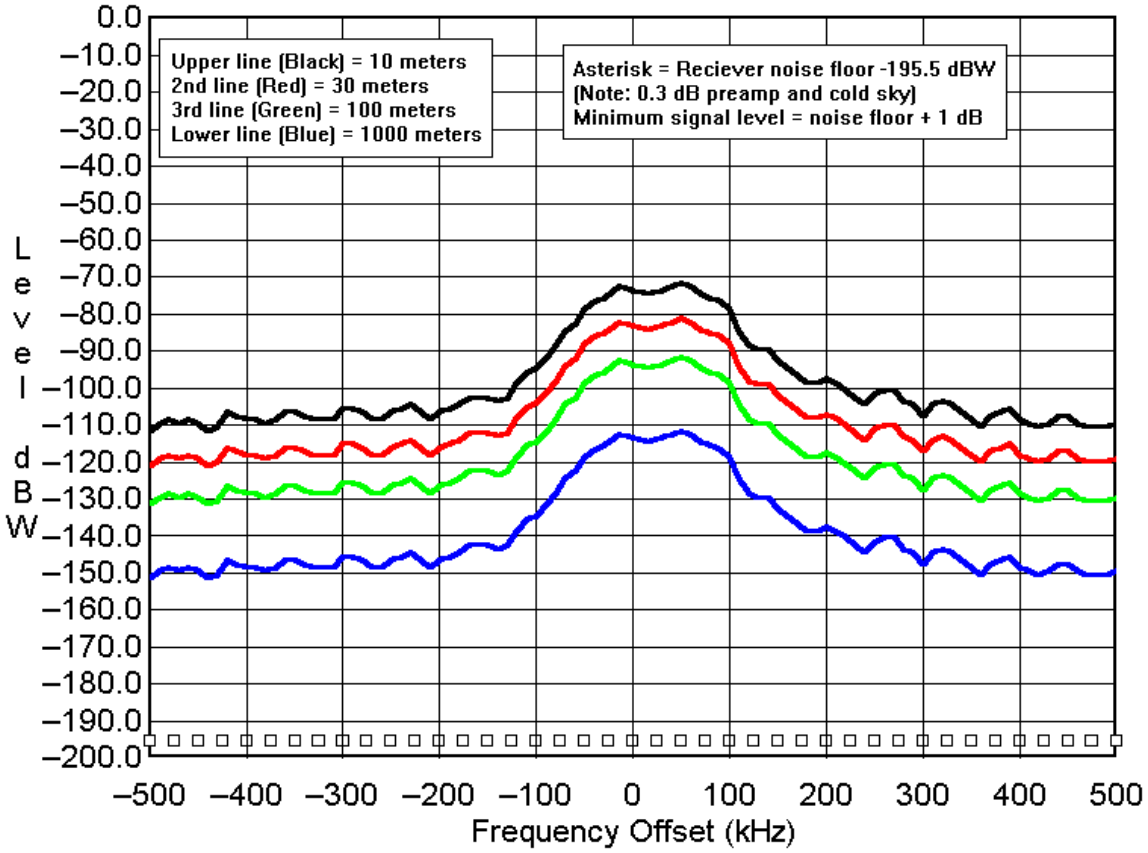


Figure 12. These data show the expected RFID system levels from the typical RFID transmitter generating 11,000 µV/m at 3 meters. The amateur station is a CW earth-moon-earth (EME) terrestrial receiving station using a 26.0-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 11,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 27.8 dB to account for the receive system bandwidth of 0.05 kHz. This amateur station typically has about –195.5 dBW of receiver sensitivity (0.3 dB NF preamplifier and a cold sky target) and a signal margin of approximately 1 dB for minimal communication.

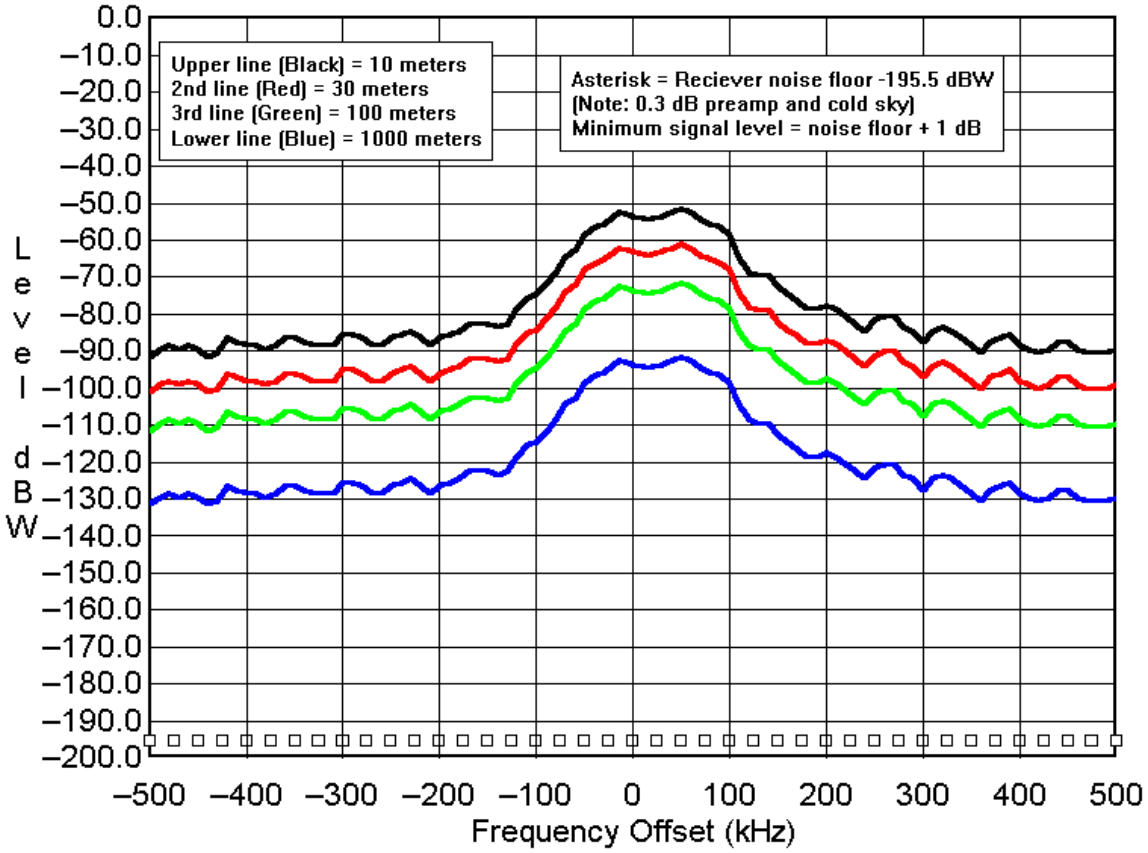


Figure 12. These data show the expected RFID system levels from the typical RFID transmitter generating 110,000 µV/m at 3 meters. The amateur station is a CW earth-moon-earth (EME) terrestrial receiving station using a 26.0-dBi gain antenna. The antenna is located at a distance of 10 meters, 30 meters, 100 meters and 1000 meters from the point at which the field is 110,000 µV/m. The predicted levels from the RFID transmitter have been adjusted downward by 27.8 dB to account for the receive system bandwidth of 0.05 kHz. This amateur station typically has about –195.5 dBW of receiver sensitivity (0.3 dB NF preamplifier and a cold sky target) and a signal margin of approximately 1 dB for minimal communication.